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ABSTRACT

A vehicle rearview mirror and a vehicle control system incorporating such mirror

A vehicle control system comprises an industry standard CAN network with a number of nodes distributed around the vehicle for controlling corresponding parts of the vehicle. One such node (40) is located in the housing (12) of the vehicle interior rearview mirror (18) and directly controls the reflectivity of an electro-optic mirror unit (28), in accordance with the state of at least one ambient light sensor, and a remote keyless entry device (20). The node (40) also communicates via an ISO9141 interface with a number of slave controllers such as a sun-roof control module (44) mounted adjacent a sun-roof (14) and a roof control module (42) mounted in a roof housing (16). By this means the UEM (40) exercises indirect control of the sun-roof (14) in accordance with the state of a switch (32), and exercises indirect control of various lamps GEN1, GEN2, FLL and FRL in the roof housing (16) in accordance with the state of switches Gen, FL and FR mounted in the roof housing (16) or, in the case of the lamps GEN1 and GEN2, when a vehicle door is opened.

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A VEHICLE REARVIEW MIRROR AND A VEHICLE CONTROL SYSTEM INCORPORATING SUCH MIRROR

The present invention relates to a vehicle rearview mirror and a vehicle control system incorporating such mirror.

According to the present invention there is provided a vehicle rearview mirror comprising a mirror housing containing a variable reflectivity mirror unit and a microcontroller for controlling the reflectivity of the mirror unit.

There is also provided, as a further independent invention, a vehicle control system comprising a rearview mirror housing, a variable reflectivity mirror unit mounted in the mirror housing, a master microcontroller mounted in the mirror housing for controlling the reflectivity of the mirror unit, a roof housing positioned on the interior roof of the vehicle, a slave microcontroller mounted in the roof housing and connected to the master microcontroller, and at least one input and/or output device connected to the slave microcontroller.

There is also provided, as a further independent invention, a vehicle control system comprising a network controlling a plurality of functions of the vehicle, the network having a node located in a rearview mirror housing of the vehicle, such node controlling at least one function of the mirror.

There is also provided, as a further independent invention, apparatus for controlling an optical characteristic of a vehicle component in accordance with the duty cycle of a pulse width modulated signal.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a vehicle including a control system according to the invention;

Figure 2 is a schematic view of the upper windscreen and front roof area of the vehicle and control system of Figure 1;

Figure 3 is a block circuit diagram of the UEM 40 in the rearview mirror housing of Figure 2;

Figure 4 is a block circuit diagram of the RCM 42 in the roof housing of Figure 2; and

Figure 5 is a flow diagram illustrating the method by which the node of Figure 3 controls the reflectivity of an electro-optic mirror.

Referring now to the drawings wherein similar numerals have been used to indicate like parts, a vehicle control system comprises a network of nodes 10 distributed about the vehicle 11. Each node 10 controls the operation of particular part of the vehicle, e.g. the engine, brakes, door locks, etc. In the embodiment of the invention, one of the nodes, identified as UEM in Fig. 1, is located in the housing of the vehicle interior rear view mirror as will be described.

Each node 10 in the network communicates with each other node using an industry standard CAN (Controller Area Network) network protocol. A CAN network is a multi-master CSMA/CA (carrier sense multiple access collision avoidance) arbitrated bus, such as has been

developed by Bosch specifically for use in the automotive industry where it is critical that messages be executed within a pre-determined time span; see, for example, PCT Application Nos. WO 90/01739 and WO 94/06081. Each node includes a controller having a back end and a front end. The back end of the controller is connected to sensors and actuators while the front end communicates with each of the other node front ends across a two-wire bus, CAN_H, CAN_L.

The front end of each node controller in a CAN network has a memory containing a table of node-specific message identifiers. Only messages with these identifiers can be transmitted or received by the node. There is a maximum of 2048 identifiers. For transmission, the back end of the controller writes a message to a message buffer in the front end controller and sets a flag. The transmission is then automatically executed by the front end of the controller. The front end decides whether to process a message placed on the network by any other node using an acceptance filter. The criterion for this decision is the identifier included in every message. Only messages, which pass the acceptance filter are stored in the receive buffer and transferred to the back end controllers memory.

There are a number of commercially available microprocessors incorporating CAN controllers, for example, a Motorola MC68H08, Philips PCA 82C200 or Intel AN 82526. These controllers enable nodes to communicate with one another to transmit the status of sensors or actuators across the network. It will be seen that because only a two-wire bus is required to connect each of the nodes on the network together, significant weight savings can be made in the vehicle's electrical harness.

In the present embodiment, a CAN node 40 for controlling electronic equipment in the upper area of the vehicle, referred to as a UEM (upper electronics module), is located inside the housing 12 of an interior rearview mirror 18, Figure 2. It is advantageous to place the UEM 40 in the mirror housing as it is less susceptible to noise and excess temperatures than if it were located in or adjacent the roof cavity of the vehicle. It is therefore possible to use a controller and associated electronics with a lower temperature rating than if the UEM 40 were placed in the roof cavity. If a higher rated controller is used, however, it can perform more reliably than if it were located in the roof cavity.

The mirror 18 contains an electro-optic mirror unit, that is, a mirror unit of a type whose reflectivity can be varied as a function of an applied voltage. In the present embodiment the mirror unit comprises an electro-optic cell (EC) 28. As is well known, an electro-optic cell comprises an electro-optic medium such as an electrochromic or liquid crystal material sandwiched between a pair of, usually, glass plates. When a voltage is applied across the layer it colours, or darkens, to decrease the transmissivity of the cell, the amount of darkening increasing with increasing voltage. Within the mirror housing 12 the cell 28 is located in front of a reflecting surface (or alternatively the reflecting surface may be formed directly on one of the glass plates) so that, as seen by the driver, the reflectivity of the mirror decreases with increasing voltage. The construction and operation of such mirrors is very well known in the art; see, for example, U.S. Pat. Nos. 5,140,455, 5,572,354 and 5,151,816, and European Application No. 92308022.0, or as described for example in the following papers: N.R. Lynam, "Electrochromic Automotive Day/Mirrors", SAE Technical

Paper Series, 870636 (1978); N.R. Lynam, "Smart Windows for Automobiles", SAE Technical Paper Series, 900419 (1990); N.R. Lynam and A. Agrawal, "Automotive Applications of Chromogenic Materials", Large Area Chromogenics: Materials & Devices for Transmittance Control, C.M. Lampert and C.G. Granquist, eds., Optical Eng'g Press, Washington (1990).

In the present embodiment the electronic equipment in the upper area of the vehicle which is controlled by the UEM 40 includes the electro-optic cell (EC) 28 of the mirror 18, a remote keyless entry (RKE) unit 20, a vehicle sun-roof 14, an alarm siren (not shown), and various lamps, switches and other equipment contained in a roof housing 16 positioned on the interior roof of the vehicle. The UEM 40 controls the cell 28 and the RKE unit 20 directly, but controls the other equipment indirectly via respective slave controllers which communicate with the UEM 40 via a local sector network which, in the present embodiment, is a half-duplex master-slave network. These other controllers are a roof control module (RCM) 42 located in the roof housing 16, a siren control module (SCM, not shown) and a sun-roof control module (SRCM) 44. In the present embodiment, master-slave communication is implemented across a conventional single-wire, UEM_K3, interface complying with ISO9141.

Turning now to Figure 3, the UEM 40 of the present embodiment includes a Motorola MC68H08 microcontroller 22 mounted on a printed circuit board (PCB) within the mirror housing 12. The controller is connected to the CAN bus via a CAN interface circuit 23 which includes a Philips PCA82C250 CAN transceiver. The transceiver complies with ISO/DIS 11898 and converts the two-wire

CAN bus signal into separate Rx and Tx signal lines which connect to respective input and output pins on the controller 22.

The controller 22 is connected to an input circuit 24 and an output circuit 26 for controlling the transmissivity of the electro-optic cell 28 and hence the reflectivity of the mirror 18.

The input circuit 24 comprises a series of three resistors RA, RG and RB which are used to determine the ambient light levels around the vehicle. Both RA and RG are light dependent resistors whose resistance is inversely proportional to the level of light falling on them. RA and RB are incorporated in respective ambient light sensors facing forwardly and rearwardly of the vehicle respectively. Since the construction and operation of such sensors is well known only the electrically operative part, the resistors themselves, are shown in the drawings. The node between RG and RA is connected via buffer circuitry 32 to an analog input pin Vglare of the controller. In conditions where the vehicle is lit primarily from the rear by the headlights of another vehicle, the level of light falling on RG exceeds that falling on RA and the voltage drop across RG decreases. Vglare thus decreases which, as will be seen in Fig. 5 to be described, causes the controller 22 to decrease the transmissivity of EC 28 and hence decrease the reflectivity of the mirror 18.

It is desirable to assess the overall ambient light level in determining the mirror reflectivity so that the degree of control can be reduced in daylight or relatively bright ambient conditions. RB is a constant value resistor and the node between RB and RG is

connected via a biasing resistor 34 to an analog input pin Vec_cutoff of the controller 22. Thus, in brightening conditions, as the aggregate light level falling on resistors RA and RG increases and their resistance decreases, the voltage drop across RB also increases by a corresponding level. It will be seen that the increasing voltage drop across RB causes Vec_cutoff to rise gradually, and thus as the overall ambient light level increases the degree of control gradually decreases as also will be seen in Fig. 5.

The output circuit 26 drives the electro-optic cell 28 via a digital pulse width modulated (PWM) output pin PWM EC to control the mirror reflectivity. PWM control is necessary because the Motorola controller in the UEM 40 does not have analog outputs. It does have analog inputs which it uses, for example, to measure the battery level or to measure the sensor resistors RA, RB and RG as explained earlier. In the present case the output pin PWM EC provides a voltage level of 5 volts when it is on, and zero volts when it is off.

The cell 28 is connected to the controller 22 via a two pin jumper JP1 on the UEM PCB. A voltage difference of 1.4V supplied to the cell 28 across the two pins of the jumper is sufficient to drive the cell to minimum transmissivity and hence reduce the mirror reflectivity to a minimum, while the absence of a voltage difference between the two pins clears the cell. Therefore, a pair of resistors RD1 (100K) and RD2 (39K) are used to divide the 5 volts on the output pin PWM EC of the controller in the ratio 28:72, providing 1.4V at the junction of the resistors RD1 and RD2 for a constant 5 volts at PWM EC.

The 5 volt output signal at PWM EC is modulated by the controller 22 under software control (Fig. 5) to have an on/off duty cycle between 0 and 100%. A capacitor C23, connected in parallel with resistor RD2, is used to smooth PWM EC signals with a duty cycle less than 100% to a substantially constant voltage between 0 and 1.4V in proportion to the duty cycle. The value of the capacitor C23 is chosen as 1uF so that the corner frequency of RD1, RD2 and C23 best matches the frequency of the PWM signal. A buffer comparator 30 is connected between the voltage divided output signal and the jumper pin to provide a high impedance quick clearing output to the cell 28.

Microprocessor control of the cell 28 enables parameters controlling the level of mirror reflectivity to be programmed. These parameters are:

1. A threshold ambient light level at which the mirror should be cleared, (Vec_off);

2. Gain (G); and

3. Start of colour (Cs)

These three programmable parameters are stored in flash memory and are updated from a computer which plugs into the CAN bus through a socket (not shown) located between the front seats of the vehicle.

A software routine, Fig. 5, running continually on the controller 22 monitors Vec_cutoff and Vglare to determine the duty cycle of the 5volt signal at the PWM EC output pin. The routine first checks at step 52 whether the vehicle is in reverse. If so, the mirror is

cleared at step 54 by setting the desired value of the duty cycle of the PWM EC signal to 0% and updating the duty cycle accordingly at step 66. If not, Vec_cutoff is measured at step 56. The routine then checks at step 58 if Vec_cutoff is greater than the pre-programmed threshold level Vec_off. If so, the mirror is cleared as before at steps 54 and 66.

The routine continues by measuring Vglare at step 60 and the duty cycle of PWM EC is calculated at step 62 using the formula:

Gain x (Start of colour - Vglare)

If this formula produces a negative value, as determined at step 64, which is possible if Cs is set low, then the cell is cleared at step 54. Otherwise the duty cycle of PWM EC is updated at step 66 to the value calculated at step 62, whereupon the routine waits for a pre-determined delay 68 before returning to step 52.

Returning to Fig. 3, the controller 22 communicates with each of the RCM, SCM and SRCM slave controllers via the single-wire bus UEM_K3. The half-duplex signalling on UEM_K3 is converted by a conventional ISO 9141 compatible interface circuit 25 into separate Rx and Tx signal lines which connect to respective input and output pins on the controller.

The controller 22 communicates with respective controllers in the slave devices in a frame format comprising a plurality of words, each word comprising 1 start bit, 9 data bits and 1 stop bit. The controller 22 intermittently transmits a polling frame including a header word, a body comprising up to 8 words and a 1

word checksum onto the bus, UEM_K3. The header word includes a four bit frame ID, a four bit negated frame ID, for error checking, with the 9th bit always set to 1. The nine bit format allows for a parity bit to be used for each word in the body although this is not necessary. The checksum is a modulo 256-sum of the data bytes.

If a slave controller sees a frame for which it is to respond, it replies by transmitting a frame including the relevant data back to the controller 22.

Figure 4 is a schematic illustration of the RCM 42 contained in the roof housing 16. In the present embodiment, the RCM 42 includes a Motorola MC68HC05D9 microcontroller 30 mounted on a PCB in the roof housing 16. The RCM controller 30 communicates with the UEM controller 22 via the bus UEM_K3, through jumpers JP0 and JP3 on the UEM and RCM PCBs respectively. The half-duplex signalling on UEM_K3 is converted by an interface circuit 31 circuit corresponding to the interface circuit 25 of the UEM 40 which converts the UEM_K3 signal into separate Rx and Tx signal lines which connect to respective input and output pins on the controller 30.

The RCM controller 30 is connected to three switches FL, Gen and FR mounted on the RCM PCB in the roof housing 16. Each switch includes switch contacts located behind respective buttons exposed at the surface of the roof housing 16 which are actuable from within the vehicle cabin to open and close the switch contacts. Each switch has an associated LED L1, L2, L3 which are wired in series and connected between the battery voltage Vbb and via a current limiting resistor RL to the collector

of a transistor Q1. The base of Q1 is connected to a digital output pin LED O/P via a resistor-divider network RD5, RD6. In low ambient light conditions, as determined by the controller 30 over the CAN network, LED O/P is switched high to turn on the transistor Q1 and light the LED's which in turn illuminate the buttons of their respective switches FL, Gen, FR.

The RCM controller 30 is further connected to a four way sun-roof switch 32 also mounted within the roof housing 16, Figure 2, the switch 32 also having an LED for inbuilt illumination of the switch. A suitable switch is manufactured by Alps Electric Co. Ltd. Japan. The switch 32 is connected to the controller 30 via a 5-wire flexible bus to a jumper JP2 on the RCM PCB. The collector of the transistor Q1 is connected via a driver circuit 33 to a pin, Light, on the jumper JP2 so that when LED O/P is switched high, the 4-way switch is also illuminated.

The 4-way switch includes outputs indicating the direction a user wishes to move the sun-roof 14 - forward (FWD), backward(BWD), tilt (Tilt) and automatic open (Auto). Each output is connected to a respective input pin on the controller 30 via the jumper JP2. When any output changes state, the controller 30 waits to be polled by the UEM controller 22 before transmitting the information relating to the change of state of the switch 32.

The UEM controller 22 then polls the controller (not shown) in the SRCM 44 via UEM_K3 to instruct the sun-roof controller to move the sun-roof, or not, in the appropriate direction. It will be seen that because the sun-roof switch 32 is not connected directly to the

sun-roof 14, but via the UEM 40, the conditions under which the roof opens/closes or tilts can be user specified. For example, the user could specify that the sun-roof should not open if the vehicle is travelling faster than 150km/h. In this case, when the UEM controller 22 is notified by the controller 30 of a change in state of one of the sun-roof switches, it can then seek out the value of the vehicle speed variable across the CAN bus. If this value is greater than 150km/h, then the sun-roof controller will not be signalled to open.

The technique whereby the RCM controller 30 communicates a change in state of an input to the UEM controller 22 which in turn instructs a slave node, for example the RCM 42 itself, to actuate an output, is also applied to the switching of lamps located around the vehicle.

A number of such lamps are mounted on the RCM PCB in the roof housing 16, that is, two general lamps GEN1, GEN2 and left and right front reading lamps FLL and FRL, Figs. 2 and 4. Each lamp is switched by an output pin of the controller 30 via a quad high side driver SW1 to the battery voltage Vbb. The RCM controller 30 is further connected to a vanity lamp (not shown) located above a front sun-visor and two rear side rail reading lamps (not shown) through a second quad high side driver SW2. These lamps and the respective switches (not shown) for the side rail reading lamps are connected to the RCM PCB via the jumper JP3.

The RCM 42 uses PWM control to ramp the voltage supply when turning on the general lamps GEN1 and GEN2, and to control the final voltage supplied to the general lamps as well as the voltage supplied to the vanity lamp and

to the front reading lamps FLL, FRL to prevent overdriving the lamps due to variations in the battery level Vbb.

The general lamps GEN1, GEN2 are both ramped on when a vehicle door is opened, or when the Gen switch is closed, in the following manner. In the former case the opening of a door is signalled across the CAN bus to the UEM controller 22 in known manner, while in the latter case the controller 30 reports the closure of the Gen switch to the UEM controller 22. In either case the controller 22 then instructs the RCM controller 30 across the bus UEM_K3 to turn on the general lamps GEN1, GEN2 by specifying a maximum PWM duty cycle of a 5v PWM output pin, General. This specified maximum PWM duty cycle is inversely proportional to the battery voltage Vbb, which is determined by the UEM controller 22 via a resistor-divider network RD3, RD4, Figure 3.

The General output pin is connected to two inputs on the quad high side driver SW1. When enabled by a 5v signal from the General output pin, these inputs connect the battery voltage Vbb to the respective general lamps GEN1, GEN2; thus the battery voltage supplied to the lamps GEN1, GEN2 is pulse width modulated with the same instantaneous duty cycle as the voltage at the General output pin.

The RCM controller 30 steps the General output from 0% to the maximum PWM duty cycle specified by the UEM controller 22 over a pre-determined number of steps as a function of time. In order to smooth the PWM modulated battery voltage supplied to the lamps GEN1, GEN2, FLL and FRL, a respective smoothing capacitor CS1...4 is associated with each lamp. By matching the step

increments to the increasing resistance value of the lamp filaments as they heat up, the power dissipated by the lamps is ramped approximately linearly and so the problem of lamp failure due to thermal shock is mitigated.

Similarly, the RCM controller 30 is instructed to turn on the front reading lamps FLL, FRL and the vanity lamp located in the sun visor by the UEM controller 22. In the case of the front reading lamps, the RCM controller 30 detects the closing of switch FL or FR and reports this to the UEM controller 22. The UEM controller 22 then instructs the RCM controller 30 to turn on the respective lamp FLL or FRL by enabling output F1 or F2 and specifying a constant PWM duty cycle of the voltage at an output, PWM Const, of the controller 30. As before, the specified PWM duty cycle is inversely proportional to battery level.

In the case of the vanity lamp, the RCM controller 30 is instructed to switch the vanity lamp on by the UEM controller 22 when the latter sees across the CAN bus that the sun-visor has been pulled down. This is done by enabling the Vanity output of the controller 30 and again specifying a constant PWM duty cycle of the voltage at the output PWM Const inversely proportional to battery level.

Each of the outputs F1, F2 and Vanity is "anded" with the output PWM Const so that only that lamp whose output from the controller 30 is enabled will illuminate. It will be observed that in contrast to the general lamps, the reading and vanity lamps are not ramped up but are switched on immediately to the specified constant PWM duty cycle. This reduces the amount of software control

that would have been required to produce three independent PWM signals.

It will be recognised that the conditions under which the any of the lamps connected to the RCM 42 are switched on and off can be customised by programming the UEM controller 22. For example, the controller 22 could be programmed to ignore the opening of a door or the switching on of one of the switches FL, Gen or FR if it determined that the ambient light level were sufficiently high not to warrant turning on the corresponding lamp. The voltage at the junctions of the resistors RA, RG, RB which control the electro-optic cell 28 could be used for determining ambient light level for this purpose, or the ambient light level can be determined by the UEM controller 22 across the CAN bus from a separate light sensor.

It will be seen that by using the CAN network protocol, it is possible to, for example, phone your car dealer, request changes to the programming of your car and have them downloaded via the phone and CAN bus, without needing to bring the vehicle to a garage.

The RCM 42 is also connected to a climate control unit 33 including a fan and a thermistor (not shown). Power is supplied to the fan from the RCM 42. A Fan output of the controller 30 is connected to an input of the driver SW2. The corresponding output of the driver SW2 is connected to a pin FAN on a jumper JP4. The thermistor has two terminals connected directly to respective pins THS, TLS on the jumper JP4. These pins are connected to respective pins on the jumper JP3 which are in turn connected via the vehicle harness to respective pins on the UEM jumper JP3. The differential [illegible]

through conditioning circuitry 27 and connected to an analog input Temp of the UEM controller 22. The temperature of the vehicle cabin can thus be relayed by the UEM controller to any other nodes across the network.

For example, if the temperature of the cabin rose to dangerous levels while the vehicle were stationary and the presence of a child in the vehicle were detected by a seat indicator (see below), the sun-roof could be instructed to open slightly by the UEM controller 22.

In a typical CAN network, vehicle parameter values are usually calculated at one node. If another node wishes to determine the value of the parameter, it requests the value by placing a request on the network. It will be seen, however, that due to the limitation in the number of message identifiers and bandwidth of the network, there is a cost in software in communicating sensor/actuator values across the network. The UEM 40 of the present embodiment therefore includes hardware RD3, RD4 for determining the status of the battery voltage level Vbb, which is a continually monitored vehicle parameter, rather than use valuable network bandwidth.

The UEM controller 22 also controls the remote keyless entry RKE unit 20 which is also mounted within the mirror housing 12. The UEM 40 is connected to the RKE unit 20 via a two pin jumper JP5. 5v power is supplied to the RKE unit 20 from the RKE Power output pin on the controller 22 via one jumper pin and data is returned by the RKE unit 20 to the RKE Data input pin on the controller 22 via the second jumper pin.

It will be seen that it is not desirable for all of the vehicle electronics to be drawing battery power while the vehicle is stationary without its engine running for more than a pre-determined time. The CAN nodes of the network therefore enters a low power sleep mode.

A wake up timer having a frequency 3Hz is connected to an input pin of the UEM controller 22. When interrupted, the controller 22 interrogates the RKE unit 20 to determine if the vehicle is to be entered legitimately. During this interrupt, the controller 22 also sends a message to the SCM via UEM_K3 to tell the siren that the network is functioning normally and that an alarm is not to sound.

Battery power to the slave nodes RCM 42, SCM and SRCM 44 is supplied by the UEM 40. An RCM power output pin (RCM Power O/P) is connected to an input of a quad high side driver SW0 on the UEM PCB. A signal on this pin connects the battery voltage Vbb to a line RES which connects to the jumper JP3 on the RCM PCB via the jumper JP0 on the UEM PCB. The RES signal is in turn channelled by the jumper JP3 to the SRCM 44 on line SSS. Thus, when in sleep mode the UEM 40 can remove power from the RCM and SRCM slave nodes in the master-slave network.

An Alarm output of the UEM controller is independently connected to an input of the driver SW0. A corresponding output pin of the driver is connected to a pin (Alarm Power) on the jumper JP0 which is connected via the vehicle harness to the SCM. Thus, the UEM 40 can remove power from the SCM when the vehicle has been legitimately started.

The SCM also includes a mass motion sensor (not shown) which supplies a sensor output signal ADA to the UEM controller 22 via a mass motion sensor interface (MMS I/F). The UEM controller 22 is therefore able to determine whether an alarm should sound. It should be understood that the ADA signal will be active as soon as the car moves, but if the UEM 40 knows that a correct keyless entry to the vehicle has been affected, no alarm signal message will be transmitted to the SCM which in any case is powered down as soon as the vehicle has been legitimately started.

The mirror housing 12 also includes seat belt warning lamps 15, Fig. 3. These lamps are connected in series to the collector of a transistor Q2 whose base is connected to an output pin of the controller 22. When the vehicle ignition is turned on, the UEM 40 can determine the status of seat belt sensors (not shown) associated with seats which it determines are occupied. If any such seat belts are not secured, the UEM controller 22 switches on the seat belt warning lamps 15 which are displayed prominently on the mirror housing 12 where they are sure to be noticed by a driver of the vehicle.

It will be appreciated by those skilled in the art that the invention can be used to control a prismatic mirror rather than an electro-optic mirror as described. Prismatic mirrors are well known in the art and include a prism which can be moved between first and second angular positions providing different degrees of reflectivity as seen by the driver. In the context of the present invention such a prism can be motor driven between its first and second positions, to achieve a variable reflectivity mirror, with control of the motor being effected by the UEM controller 22 in accordance

with the signals from the ambient light sense resistors RA, RG and RB. Since prismatic mirrors normally have only two states, PWM would not be necessary in that case and the output from the controller 22 could be a single signal which was either on or off according to the desired angular position of the prism. Alternatively, a prismatic mirror can be manually actuated between two angular positions to give a variable reflectance mirror.

Also, while the invention has been described herein in terms of a CAN network, the invention could alternatively be implemented in any other suitable network, for example a network conforming to the French standard VAN (Vehicle Area Network) or the US standard J1850, or a purpose designed proprietary network could be used.

It will be further appreciated by those skilled in the art that various other vehicle components and systems may be associated with the vehicle control system and/or rearview mirror as described herein. For example, a battery level indicator, various lighting systems, vehicle tyre indicators, blind spot warning data, GPS antenna and directional information, intelligent vehicle highway system information, safety warning system information, rain sensor information provided by windshield contacting or non-contacting sensors, compass information for example from flux gate, magneto inductive or magneto resistive compasses, temperature information, trainable or universal garage door opening systems, vehicle seat positioning and occupancy detection systems, intrusion detection systems, cellular telephone and pager systems, emergency rescue systems, sunroof (which could be electro-optic) control system and memory storage of various functions and data

applicable to the above in addition to any other desirable vehicular information.

It will also be seen that the vehicle control system can be used to control one or more outside electro-optic, for example, electrochromic mirrors (not shown). This can be achieved by hardwiring the UEM 40 to the or each outside mirror, similar to the way in which the vanity lights are connected to the RCM 42; or by connecting the UEM via the bus UEM_K3 to one or more slave outside mirror controllers (not shown) which control the or each outside mirror; or by connecting the UEM via the CAN bus to a another CAN node for controlling the or each outside mirror.

The invention is not limited to the embodiments described herein which may be modified or varied without departing from the scope of the invention.

CLAIMS

1. A vehicle rearview mirror comprising a mirror housing containing a variable reflectivity mirror unit and a microcontroller for controlling the reflectivity of the mirror unit.

2. A vehicle rearview mirror according to claim 1, further including connection means adapted to connect the microcontroller to a vehicle control network, the microcontroller forming part of a node of said network.

3. A vehicle rearview mirror according to claim 2, wherein the mirror housing further includes at least one seat belt warning lamp for indicating that the seat belt of an occupied seat is not fastened.

4. A vehicle rearview mirror according to claim 2, wherein the mirror housing further includes a remote keyless entry device.

5. A vehicle rearview mirror according to claim 2, wherein the vehicle control network is a CAN network and the node is a CAN node.

6. A vehicle rearview mirror according to claim 2, wherein the connection means is further adapted to connect the microcontroller in the mirror housing to a further microcontroller located exterior to the mirror housing, the microcontroller in the mirror housing and the further microcontroller being in master/slave relationship.

7. A vehicle rearview mirror according to claim 6, wherein the master microcontroller communicates with the

slave microcontroller according to an ISO 9141 communication protocol.

8. A vehicle rearview mirror according to claim 1, wherein the reflectivity of the mirror unit is varied under software control according to a selected value of at least one parameter.

9. A vehicle rearview mirror according to claim 1, wherein the microcontroller controls the reflectivity of the mirror unit according to the state of at least one ambient light sensor.

10. A vehicle rearview mirror according to claim 9, wherein the mirror unit includes an electro-optic cell whose transmissivity varies according to the level of a voltage applied to the cell to vary the reflectivity of the mirror unit, and wherein the microcontroller controls the level of said voltage.

11. A vehicle rearview mirror according to claim 10, wherein the level of the voltage applied to the electro-optic cell is determined in accordance with the duty cycle of a pulse width modulated signal provided by the microcontroller.

12. A vehicle control system comprising a rearview mirror housing, a variable reflectivity mirror unit mounted in the mirror housing, a first microcontroller mounted in the mirror housing for controlling the reflectivity of the mirror unit, a second microcontroller mounted in the vehicle outside the mirror housing and connected to the first microcontroller, and at least one input and/or output device connected to the second microcontroller.

13. A vehicle control system according to claim 12, wherein the first microcontroller is a master microcontroller and the second microcontroller is a slave microcontroller.

14. A vehicle control system as claimed in claim 12, further including a roof housing positioned on the interior roof of the vehicle, the second microcontroller being mounted in the roof housing.

15. A vehicle control system according to claim 12, wherein the first microcontroller controls the reflectivity of the mirror according to the state of at least one ambient light sensor.

16. A vehicle control system according to claim 15, wherein the mirror unit includes an electro-optic cell whose transmissivity varies according to the level of a voltage applied to the cell to vary the reflectivity of the mirror, and wherein the first microcontroller controls the level of said voltage.

17. A vehicle control system according to claim 16, wherein the level of the voltage applied to the cell is determined in accordance with the duty cycle of a pulse width modulated signal provided by the first microcontroller.

18. A vehicle control system according to claim 14, wherein the roof housing contains at least one vehicle interior lamp and the second microcontroller controls the operation of the lamp.

19. A vehicle control system according to claim 18, wherein the vehicle interior lamp is turned on by the second microcontroller upon opening of a vehicle door,

and wherein the voltage supplied to the lamp upon said turning on is gradually increased from zero to a maximum which is a function of the vehicle battery voltage.

20. A vehicle control system according to claim 19, wherein the voltage supplied to the lamp is determined in accordance with the duty cycle of a pulse width modulated signal provided by the second microcontroller.

21. A vehicle control system according to claim 13, wherein the master microcontroller is a node on a vehicle control network.

22. A vehicle control system according to claim 21, wherein the master microcontroller communicates with the slave microcontroller according to an ISO 9141 communication protocol.

23. A vehicle control system according to claim 13, wherein at least two slave microcontrollers are connected to the master controller, and wherein the master microcontroller controls an output device connected to one of said slave microcontrollers in response to an input device connected to the other of said slave microcontrollers.

24. A vehicle control system comprising a network controlling a plurality of functions of the vehicle, the network having a node located in a rearview mirror housing of the vehicle, such node controlling at least one function of the mirror.

25. A vehicle control system according to claim 24, wherein said node also forms part of a local sector network including at least one further node in addition

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to said node, said node and said further node being connected in master/slave relationship.

26. Apparatus for determining an optical characteristic of a vehicle component in accordance with the duty cycle of a pulse width modulated signal.

27. Apparatus according to claim 26, wherein the component is a rearview mirror unit and the characteristic is its reflectivity.

28. Apparatus according to claim 26, wherein the component is an interior lamp and the characteristic is its brightness.

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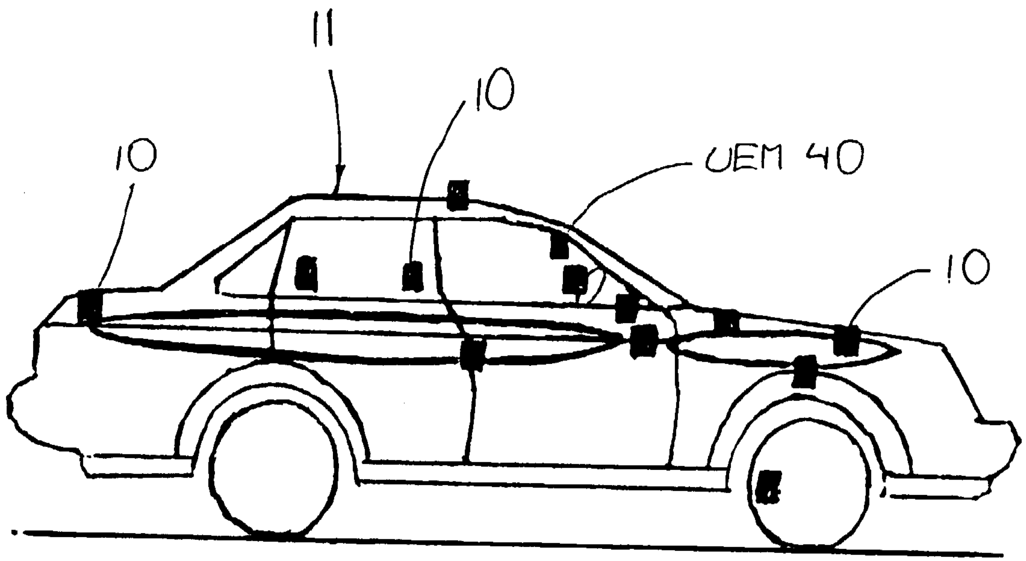

Figure 1

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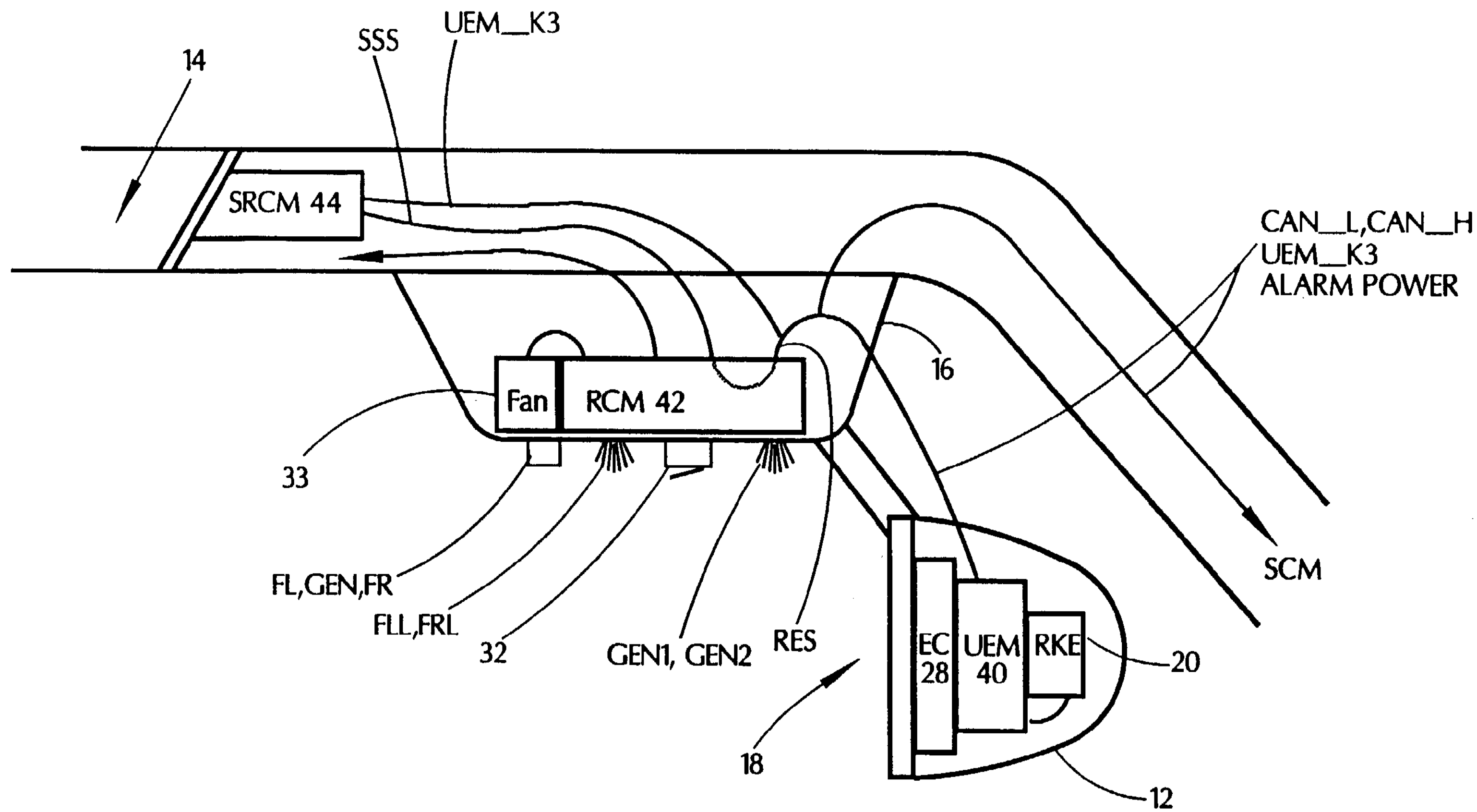

Figure 2

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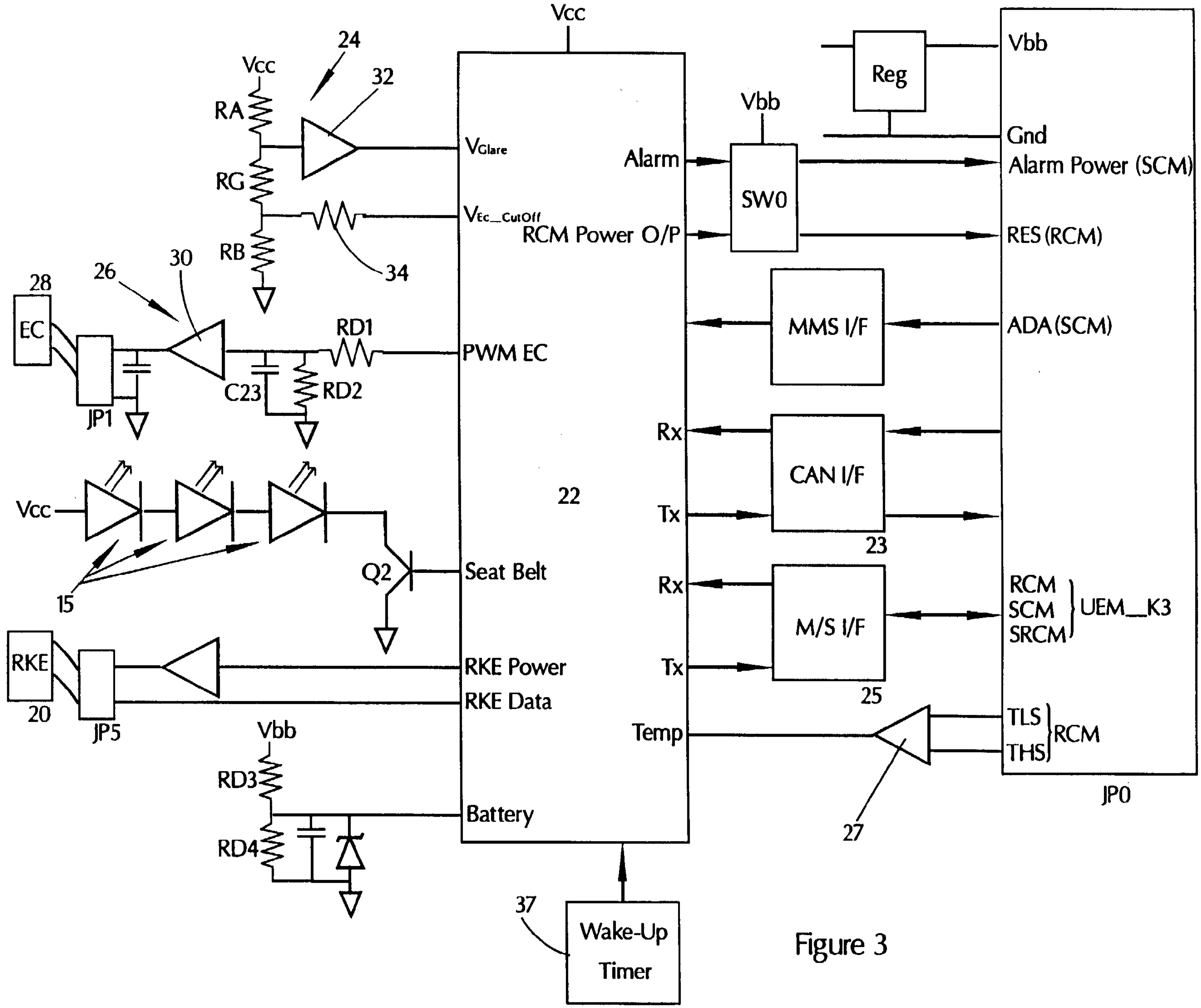

Figure 3

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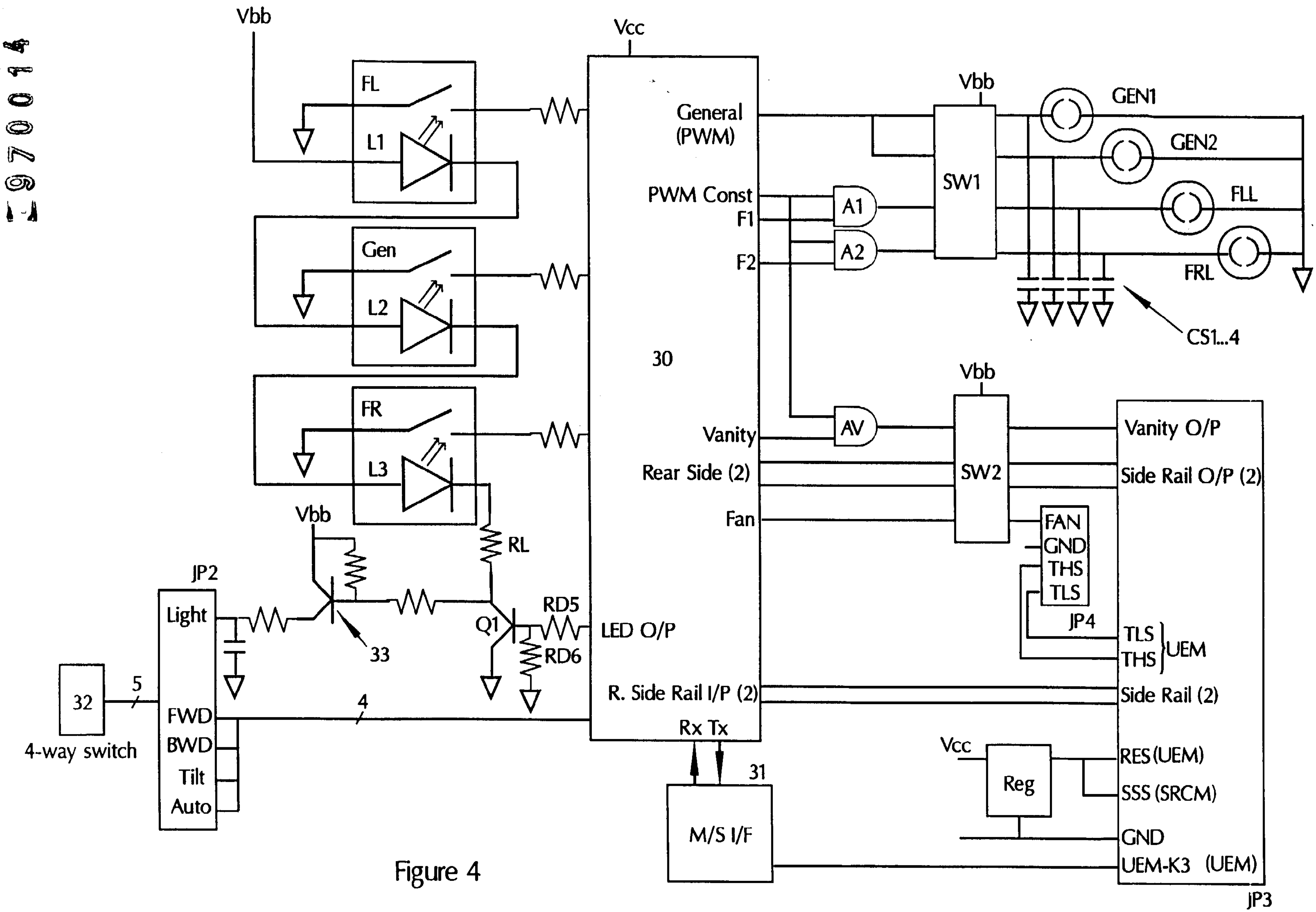

Figure 4

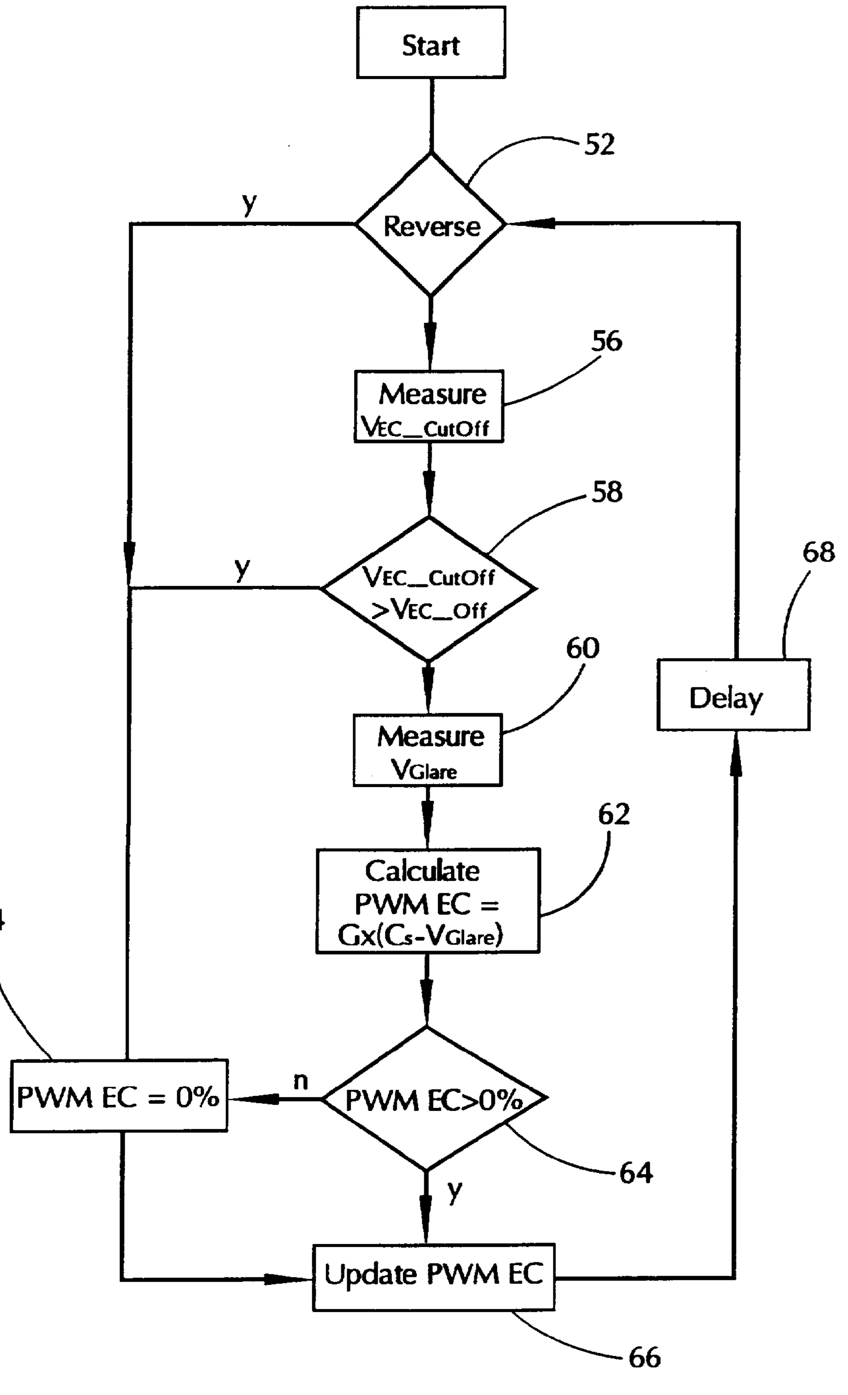

Figure 5

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